 Name Key

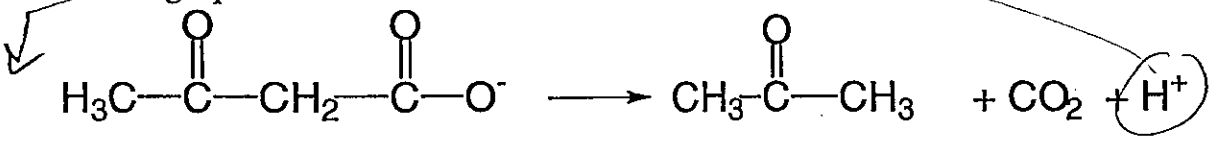
Biochemistry 5700
Fall, 1998
Exam 2
October 26, 1998

INSTRUCTIONS:

Do not begin until 10:30 AM. The exam must be turned in by 11:20 AM. This exam should have 7 questions and 8 pages. Please print your name at the top of each page of the exam. Answer **all** questions completely, concisely, and legibly in the spaces provided. Good Luck!!

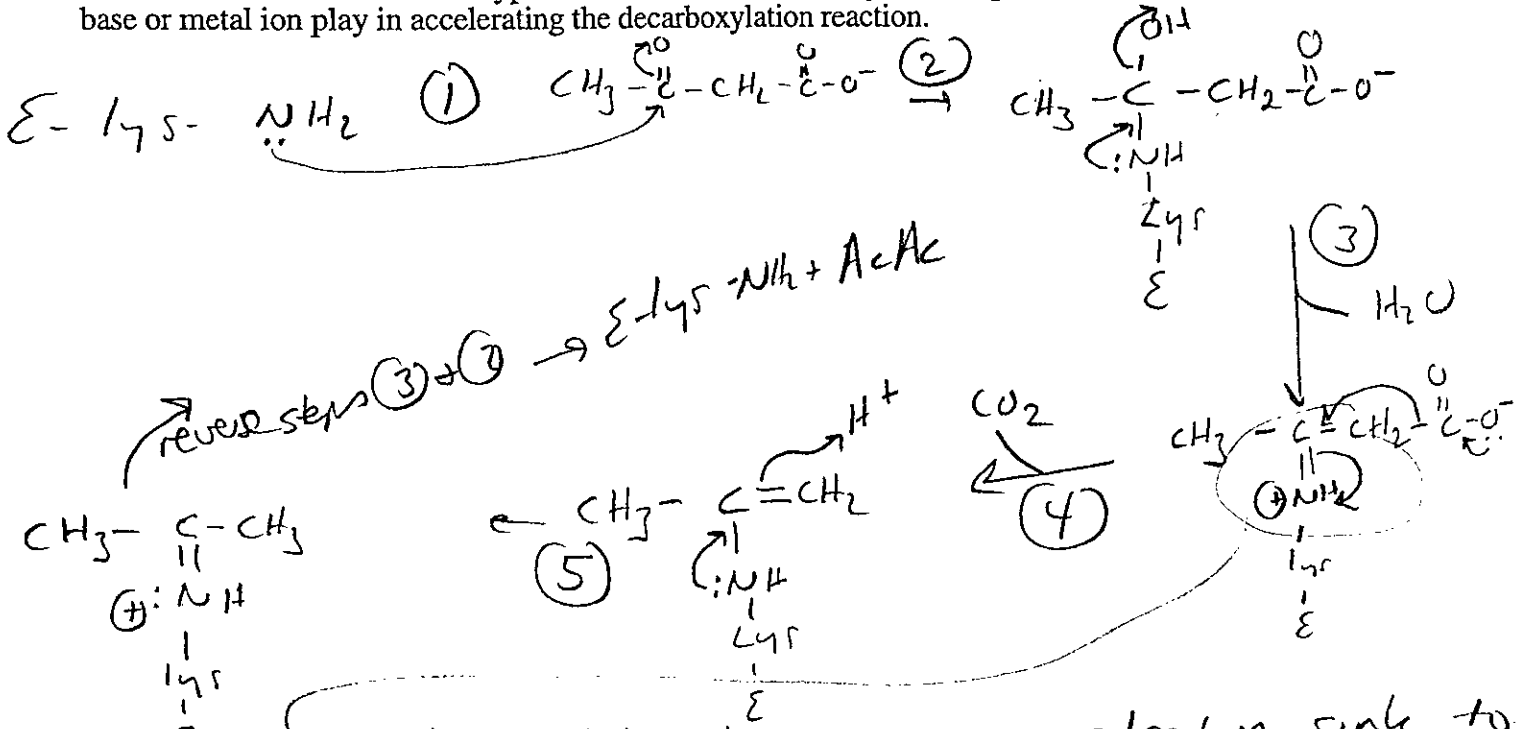
 Name Key

(1) (15 points) Acetoacetate decarboxylation forms acetone and CO_2 as products according to the following equation:

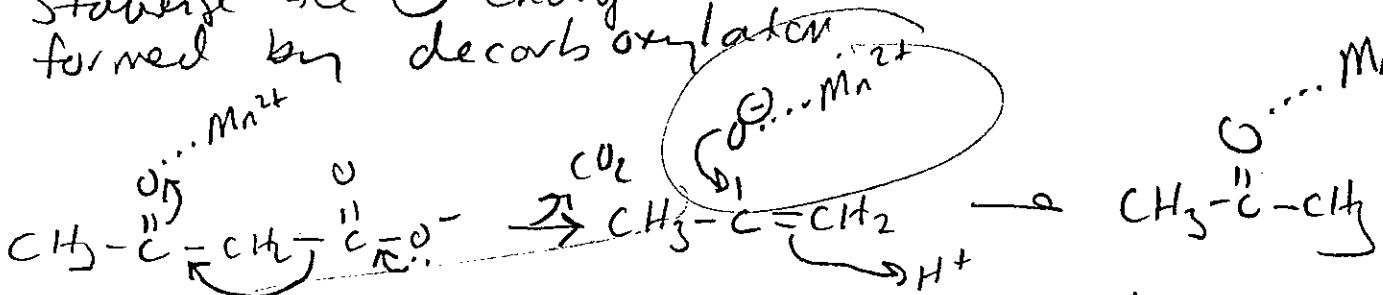


Two different types of acetoacetate decarboxylases have been characterized: one contains a catalytic lysine and proceeds via a schiff base intermediate; the other does not form a schiff base but requires a metal ion (Mn^{2+}) for catalysis. Acetoacetate is also decarboxylated nonenzymatically, but at a much slower rate than the enzyme-catalyzed reactions.

Draw mechanisms for the two types of acetoacetate decarboxylase. Explain what role(s) the Schiff base or metal ion play in accelerating the decarboxylation reaction.



The schiff base is an electron sink to stabilize the (−) charge on enolacetone intermediate formed by decarboxylation



The Mn^{2+} stabilizes the enolacetone intermediate thru electrostatic interaction.

 Name Key

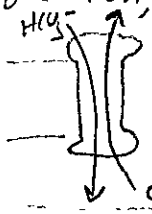
(2) (20 points)
(a) For each of the molecules shown below, predict whether the molecule would cross a biological membrane by simple diffusion or by a facilitated diffusion process.

O_2
CO_2 > simple

5 pts HCO_3^-
Glucose
K^+ > facilitated
Lactose

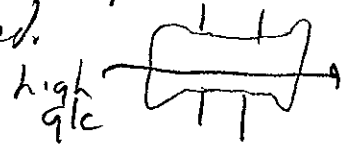
15 pts (b) For any two of the molecules listed above that are transported by a facilitated mechanism, provide a description of the mechanism of a specific transporter system that can be used to facilitate the movement of the molecule (continue on next page, if needed).

Bicarbonate: Transported via an "antiport" cotransporter - passive movement of bicarbonate, down a concentration gradient, occurs concurrently with movement of chloride ion, also down [ ] gradient, but in opposite direction.



passive; chloride: HCO3 - exchanger

glucose- transported via a uniport, passive transporter - glucose permease. glucose moves from high [ ] side to low [ ] side until equil. is established.

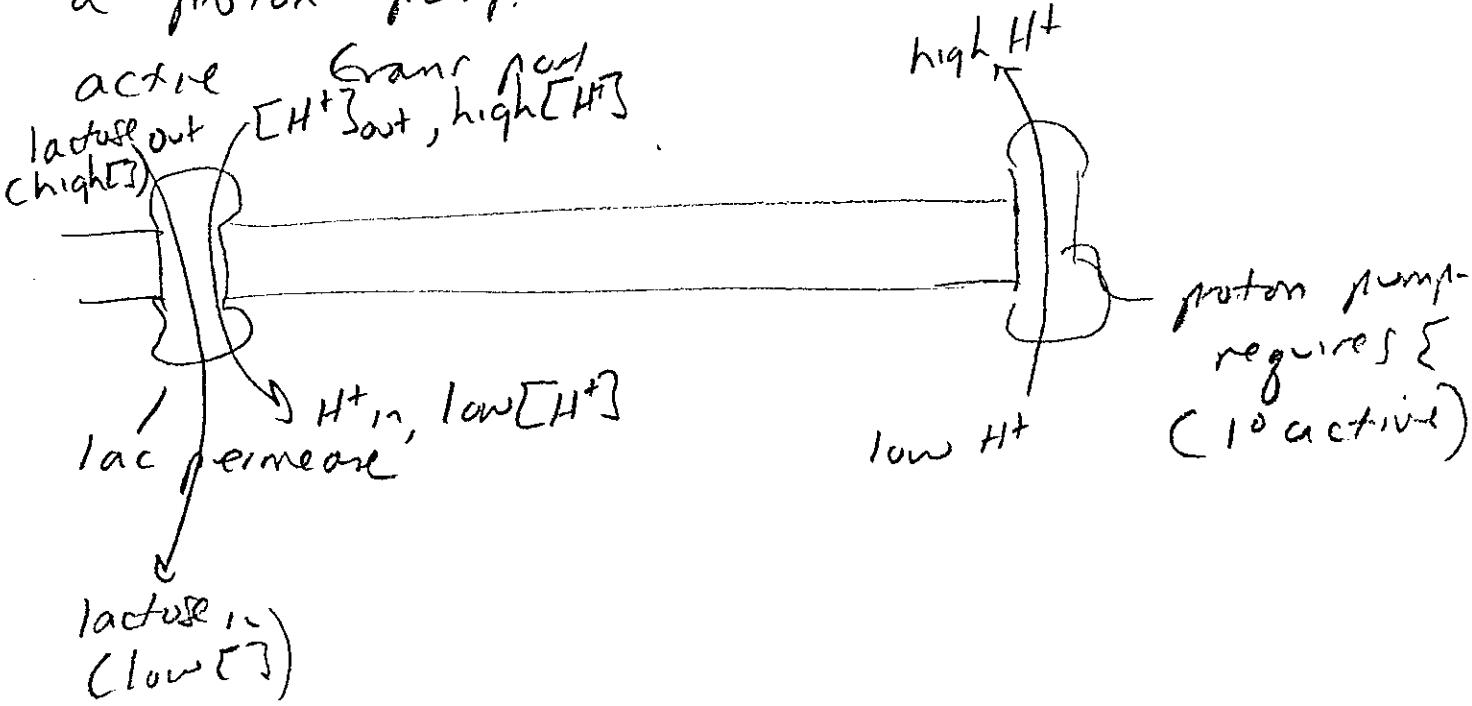


potassium- transported via primary active antiport transporter movement of 2 K^+, against [ ] gradient, is coupled to movement of 3 Na^+, against [ ] gradient in opposite direction rxn is catalyzed by Na^+/K^+ ATPase which couples solute movement to ATP hydrolysis Na^+ binds to inside of protein ATP then binds is hydrolyzed transferring a P_i group to AA residue on protein. This form of protein releases Na^+ binds K^+ on dephosphorylation results in loss of K^+ in reagent-

(2) continued- (Key)

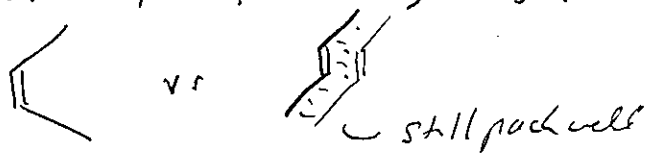
Lactose - move against [ ] gradient across membrane.

Movement is driven by symport cotransport of H^+ in same direction down a [ ] gradient. The H^+ was previously pumped out, uphill, via a proton pump. This is an example of 2° active

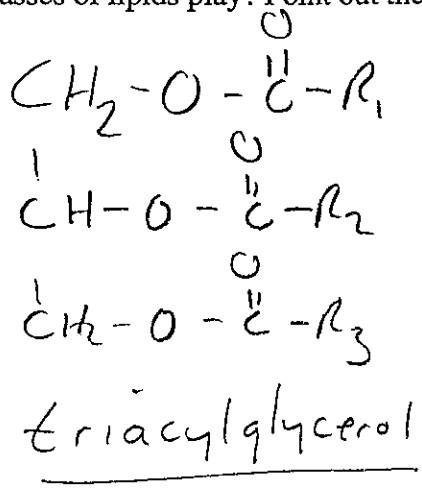


 Name Key

(3) 5 points. Explain the difference in the melting points between trans-oleic acid (44.5 °C) and cis-oleic acid (13.4°C). A cis double bond introduces a bigger "kink" into the hydrocarbon chain than does the trans bond. Here, molecules pack less tightly in cis; less IM attractions, lower melting pt.



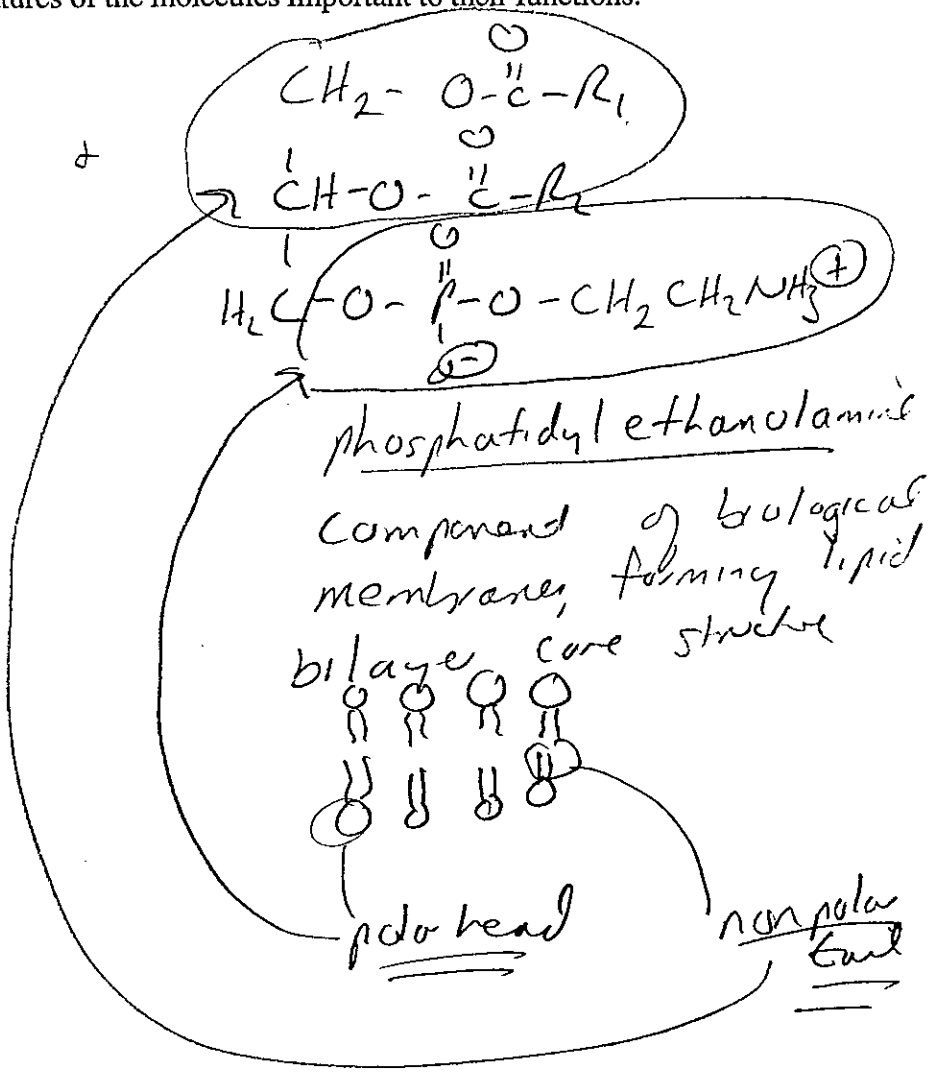
(4) 15 points) Draw the generalized structures (you may abbreviate long-chain hydrocarbon side chains by R1, R2, etc) of a triacylglycerol and a glycerophospholipid. What function(s) do these classes of lipids play? Point out the features of the molecules important to their functions.



Triacylglycerol

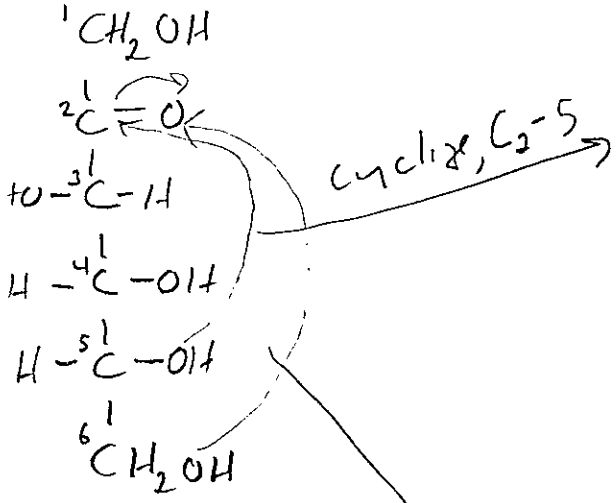
storage of energy - highly reduced storage molecule. Molecule is very nonpolar - hence can aggregate & pack w/o water hydration

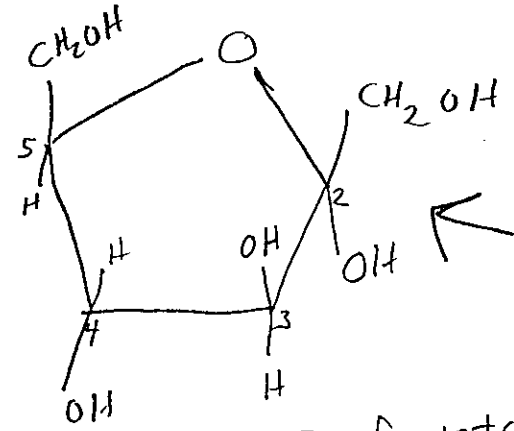
+



 Name Key

(5) 10 points. Draw structures for and name the linear, pyranose, and furanose forms of D-fructose (for the cyclic forms, draw Haworth projections; where appropriate, name the correct anomer for the structures you have drawn). Which of these three forms is the most important from a biochemical standpoint?



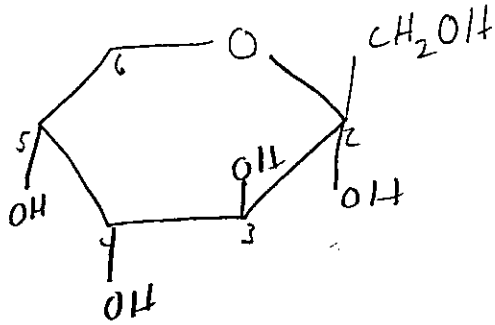


← Most important biochemically

α-D-fructofuranose

D-fru

cyclize C_2-C_6



α-D-fructopyranose

 Name Key

(6) (20 points) Polysaccharide hodgepodge of questions. 4 points each.

(a) Why can humans digest potatoes but not newspapers?

We have α-amylase, which cleaves α 1,4-linkages in starch & glycogen, but not cellulase, which cleaves the β 1,4 linkages in cellulose

(b) Why can termites digest sawdust but not lobster shells?

They have cellulase to cleave β 1,4-glc, but not chitinase, which cleaves the β 1,4 linkage in the derivatized glc residues (glucosamine) of chitin

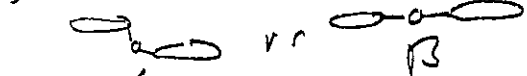
(c) Why do your tear ducts contain relatively high levels of the enzyme lysozyme? What does this enzyme do?

Lysozyme cleaves the β 1,4-linked NAM-NAG linkage that is the polysaccharide backbone of peptidoglycan, the predominant component of bacterial cell wall. Tears contain high levels to prevent bacterial invasion.

(d) Why is glycogen heavily branched rather than unbranched?

So that there are many nonreducing ends that can be simultaneously acted on by amylase enzymes. Allows more rapid breakdown.

(e) What feature(s) of cellulose make it a better structural polymer than amylose?

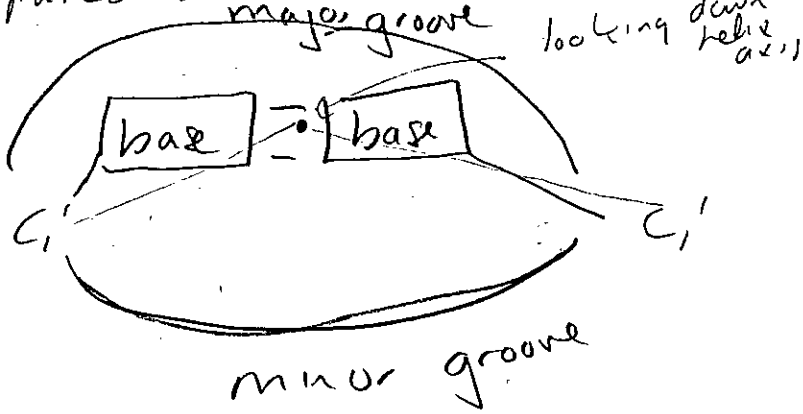
In β-D-glc, all OH groups are in equatorial plane. Linked β-D-glc molecules thus can form extended chains that can stack easily. Amylose contains α-D-glc units. Here, the C_1-OH is axial; thus the chain can't form an extended, linear form.  vs

 Name Key

(7) 15 points. Define the following terms as they relate to DNA structure:

(a) major groove

The side of DNA formed by the large angle connecting the C_1' carbons of paired bases & the center of the helix axis

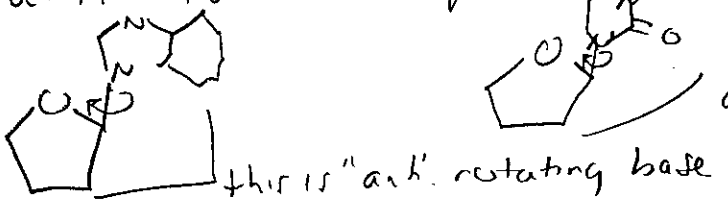


(b) minor groove

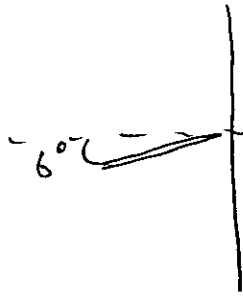
The side of DNA formed by the smaller angle defined above

(c) N-glycosidic bond orientation

The orientation about the N-glycosidic bond, which is "anti" for both purine & pyrimidine bases in B-DNA



(d) base tilt



base pairs in double helix are tilted ~6° from ⊥ plane to helix axis

(e) sugar pucker

For ribose & deoxyribose sugars the situation where 1 of 5 atoms lies out of plane of ote 4. For DNA, C2' carbon is out of plane, on same side as C5' carbon - hence "C2' endo"